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THIS ISSUE

The Buick Dynaflow Transmission

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LUBRICATION

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The Buick Dynaflow Transmission

Previous issues of this continuing series on American Automotive Hydraulic Transmissions have traced the development and commercial application of the fluid coupling[1], two different combinations of the fluid coupling with semi-automatic gear shifts[1,2], the multi-stage hydrokinetic torque converter[3] and a combination torque converter-fluid coupling with automatic gear shift[4].

This issue will describe the Buick Dynaflow Transmission which represents the first commercial application of a combination torque converter-fluid coupling to an American passenger car. The Dynaflow was publicly announced in March 1948, and then only as optional equipment on the large Buick Series 70 "Roadmaster" where it is now standard. This year the use of a slightly smaller Dynaflow converter was extended to the Buick Series 50 "Super" as optional equipment and will be still further extended to the latest high-production Buick Series 40 "Special". The fact that over 300,000 Dynaflow-equipped Buicks have been sold during the first eighteen months of Dynaflow existence coupled with the fact that 80% of the Buicks now being built are Dynaflow-equipped are both convincing testimonials to the enthusiasm with which the American public has received this pioneer of torque converter passenger car transmissions.

From Figure 1 the technically-minded will immediately recognize the Dynaflow as consisting essentially of a single stage combination torque converter and fluid coupling combined with an auxiliary planetary gear box. Because of the remarkable compactness of the assembly, however, even the expert may miss a number of highly ingenious details, hence a more thorough examination is profitable. For example, let us emphasize from the very start that the rarely-used auxiliary planetary gear box attached to the Dynaflow is very much auxiliary in nature and exists for the sole purposes of providing a neutral position, a reverse gear, a parking brake, and a rarely used emergency low gear. During practically all actual driving, the auxiliary gear box is unnecessary and inactive: the heart of the Dynaflow and the secret of its unparalleled smoothness of operation is its combination converter-coupling.

CONVERTER-COUPLING

It is presumed that the reader is familiar with the previous articles of this series and that nothing more than a refresher review will be required. For example, it will be recalled that the major constructional difference between a single stage torque converter and a fluid coupling is the presence of "reaction" or "stator" blading in the converter. We will remember that this reaction blading is responsible for the converter's ability to *multiply* or increase the applied engine torque, while the simpler fluid coupling (or fluid clutch) which has no reaction blading can merely *transmit* engine torque unchanged. In brief, a combination of a torque converter and a fluid coupling is highly advantageous since the abilities of each one nicely counteracts the deficiencies of the other. Such a combination results in an ultra-smooth completely automatic hydraulic mechanism which replaces and greatly improves

1 LUBRICATION, November 1946, Fluid Couplings and the Chrysler Semi-Automatic

2 LUBRICATION, April 1947, The Hydra-Matic

3 LUBRICATION, November 1947, The Hydrokinetic Torque Converter

4 LUBRICATION, November 1948, The White Hydro Torque Drive

upon both the conventional inflexible geared transmission and the ordinary rigid friction clutch.

From a previous article[4], we have realized that the major difficulty in obtaining such a desirable combination was to find a suitable method of removing the effect of the reaction blading whenever fluid coupling operation is desired. Actual physical removal of the reaction blading has not been successful because of the mechanical complexity involved. The Dynaflow ingeniously accomplishes the desired result of removing the *effects* of reaction blading by further subdividing the basic three groups (pump, turbine and reactor) of blading into five subassemblies, and by mounting three of these subassemblies on overrunning "one-way" clutches. While admittedly adding to its complexity and cost, such a design automatically permits each subassembly to instantly adapt itself to the complex and rapid changes in fluid direction and velocity that occur during transfer from converter to coupling operation and vice versa. Some indication of the magnitude of fluid velocities that occur is afforded by the fact that under "stall" conditions (engine delivering full torque with the car still stationary) fluid velocities as high as 28 feet per second must be attained to obtain the Dynaflow's torque-multiplying ratio of 2.25. In other words, the blading and one-way clutches are so arranged that as soon as each set of blading has accomplished its job, the one-way clutches permit it to adapt itself to and "get out of the way" of the fluid stream thereby avoiding hindrance to the remaining blading that is still contributing.

The upper photographs of Figure 2 present an "exploded" side view of the five major subassemblies in the Dynaflow converter: the lower and corresponding photographs portray the identical assemblies except that each has been turned sidewise to obtain a front view which better reveals their intricate construction. (The direction of rotation used to accomplish this change in view has been indicated by arrows with reference to the nearest edge of the side view of each assembly.) In all of these assemblies the blading portion is composed of a beautifully finished and highly homogenous aluminum alloy casting which is manufactured by using a combination of dry sand and porous plaster moulds.

The front views of the Secondary Stator, Primary Stator and Secondary Pump all show the roller type one-way clutches with which each of these assemblies is equipped. Figure 3, a schematic assembly indicates the operating position of the five subassemblies, the three one-way clutches, and the direction of fluid circulation, and will assist in the following presentation of their functions.

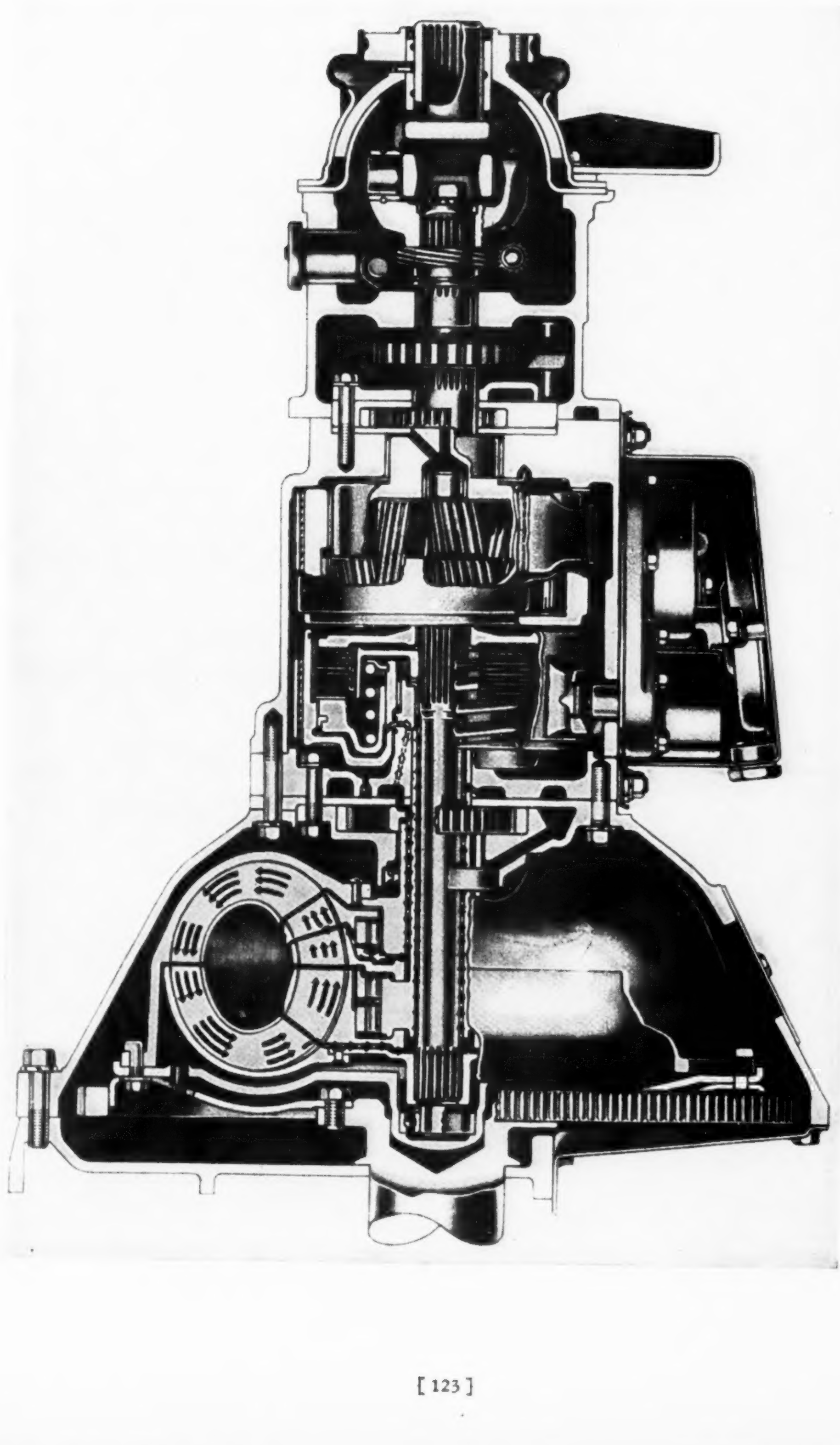
The pressed steel Pump Cover is bolted to a flexible steel flywheel carrying the starter ring gear, which in turn is bolted to the engine's crankshaft: the conventional engine flywheel is omitted since its smoothing function is now performed by the mass of the converter-coupling and its contained fluid. Since crankshaft flanges of Dynaflow-equipped engines differ from those used with conventional transmissions, it is not easily possible to interchange a Dynaflow and conventional transmission in a given car.

The Primary Pump also serves as half of the converter housing, and is bolted and gasketed at its largest diameter to the Pump Cover. The Primary Pump and Pump Cover therefore rotate with the engine at all times and together form an oil-tight external casing in which the turbine, stators, and secondary pump may rotate independently during the performance of their slightly mysterious functions. As will be seen later, the hub of the Primary Pump is extended rearward into the gear box and used to drive the forward transmission oil pump.

A casual examination of the Primary Pump as shown in Figure 2 might lead to the erroneous conclusion that it contains two sets of blades. Actually, however, there is only one set of twenty-nine blades, the central portion of which lies behind and is hidden by the torus ring half. This torus ring half, together with its mate on the turbine, forces the fluid to maintain an orderly path around the largest diameters by preventing short-circuiting. Obviously the torus ring halves also substantially strengthen the blading, although at the same time they increase the difficulty of molding each casting.

The Secondary Pump consisting of 31 blades is mounted on its one-way clutch which in turn bears upon the extended central hub of the Primary Pump. Because of the presence of its one-way clutch the Secondary Pump is driven by and must rotate at least as fast as its primary big brother, but can rotate even faster if fluid velocities require it to "get out of the way".

The Primary and Secondary Stators containing 25 and 23 blades, respectively, are both mounted on the always-stationary reaction sleeve through separate one-way clutches so that they can rotate independently of each other but only in the same direction as the pump, turbine and engine. Like the secondary pump, both stators are of such diameter that they can guide and affect fluid flow only at the innermost or smallest diameter of the converter. Restating in a different manner (and as indicated in Figure 3), fluid flows directly from the Primary Pump to the Turbine; on the return trip, however, it must flow from the innermost diameter of the turbine through both stators and the secondary pump to reach the Primary Pump. The Secondary is the first to "break loose" with increase in turbine velocity. The direction of blading angle in both stators is opposite to that of the turbine.



Courtesy of Buick Motor Division, General Motors Corporation

Figure 1 — Buick Dynaflow, cross section.

The turbine receives the fluid discharged from the pump, converts it to torque, which it transmits to the gear box, propeller shaft, and rear wheels by means of the innermost solid splined Transmission Input Shaft illustrated in Figures 1 and 3. The 31 blades of the turbine are deceptively similar to those of the primary pump. Actually, however, the close observer will notice that the turbine's blading is so curved as to cause a complete reversal in direction of flow as fluid travels from its outer to its inner diameter.

The interaction of the converter parts is most readily understood by tracing their activities through such a normal sequence as starting a car from a standing stop and accelerating up to driving speeds as follows:

a. With the engine idling, the directly connected primary pump is also slowly turning so that centrifugal forces causes the fluid to gently circulate to the periphery of the pump, thence across to the turbine and inwardly back through the stators to the pump inlet. Even though the engine is (hydraulically) connected to the car wheels, circulation of fluid is so gentle that insufficient torque is generated in the turbine and the car remains stationary. As a matter of fact, with proper idle speed adjustment, there is little or no tendency for the car to "creep" on level pavement.

b. To start the car moving, we need merely depress the throttle. If we must beat everyone else away from the stop light, we "tramp" it to the floor boards. The engine immediately accelerates to a speed approximating the peak of its torque curve — about 1550 RPM in the case of the largest Buick. The fluid in the pump is now subject to high centrifugal forces which impel it outwardly at considerable velocity and across to the turbine blading which receives its contained energy and converts it into torque. Under this condition, fluid velocity is so high and the direction is such that the secondary pump is not required to direct fluid, consequently the secondary pump "free wheels" rapidly out of the way.

c. By reason of the smaller passageways between blades at the innermost diameter of the turbine, fluid velocity is actually greatest at this point, though in a direction opposite to that required by the pump intake. The two stators therefore reverse the direction of fluid flow and impress it with virtually undiminished velocity and energy upon the pump. This velocity and energy is added to that already extracted by the turbine with the result that the whole system multiplies engine output torque about two and a quarter times.

d. As the car begins to move engine speed also increases, but to a lesser degree. At about this time the hitherto idle secondary pump is overtaken by the primary pump and the two lock together henceforth as one element. As the difference in speed between the pump (engine) and turbine (car speed) decreases further, the velocity of fluid discharged from the turbine also decreases and begins to impinge against the back sides of the secondary stator blading. This merely means that the secondary stator is no longer required as a stator. The change in direction of fluid flow accordingly causes its one-way clutch to unlock automatically with the result that secondary stator now rotates and adapts itself to the fluid stream merely as a non-active "floater". Since the primary stator is still stationary however, torque multiplication still occurs but to a lesser degree.

e. As the car continues to accelerate the difference in speed between the turbine and pumps also decreases with the result that the primary stator also "breaks loose" and free-wheels. When this occurs torque multiplication ceases, the converter has been converted into a fluid coupling, and the car is now in what would be called high gear in a conventional transmission. The fact that no gears have been used, no gear shifts have occurred, and no effort or thought has been required of the driver during the unbelievably smooth acceleration, all readily explain the popularity of the Dynaflow.

THE GEAR BOX

As previously mentioned, the Dynaflow does have a "gear box" but only as an accessory which provides a neutral position, a parking gear, a reverse gear and an ultra high powered emergency low gear. As illustrated schematically in Figure 4, the gear box consists of a single very compact and practical compound planetary which is controlled by means of two contracting brake bands and an internal multi-disc wet clutch. A compound planetary differs from the simple type previously described[2] in that two sets of planet gears (called "low planet pinions" and "reverse planet pinions") and what practically amounts to two sun gears ("low range reaction gear" and "driving sun gear") are all used in a single compact assembly. While three planet pinions are actually in each group, Figure 4 illustrates only one for sake of simplicity. In brief the elongated low range planet pinions mesh with both the driving sun gear and reverse planet gears. Similarly the reverse planet pinions mesh with both the low range reaction gear and the reverse ring gear. Both the low range and reverse planet pinions are mounted on spindles of the planet carrier which constitutes the output shaft of the transmission. Table No. 1 will assist those who may be interested in a detailed study of the ingenious but complex action of the Dynaflow compound planetary. In this con-

[2] LUBRICATION, April 1947

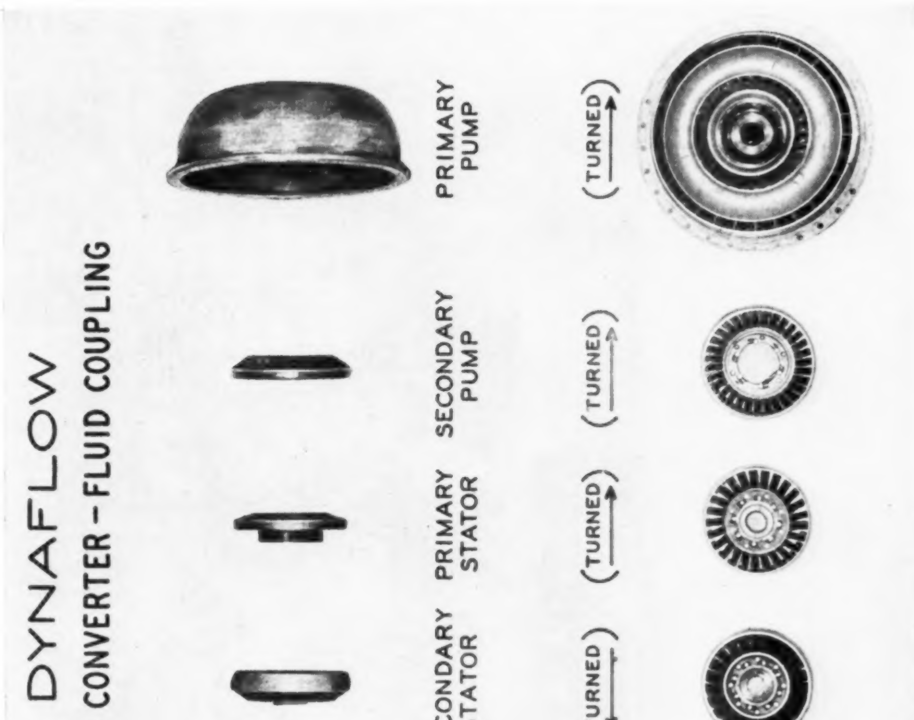


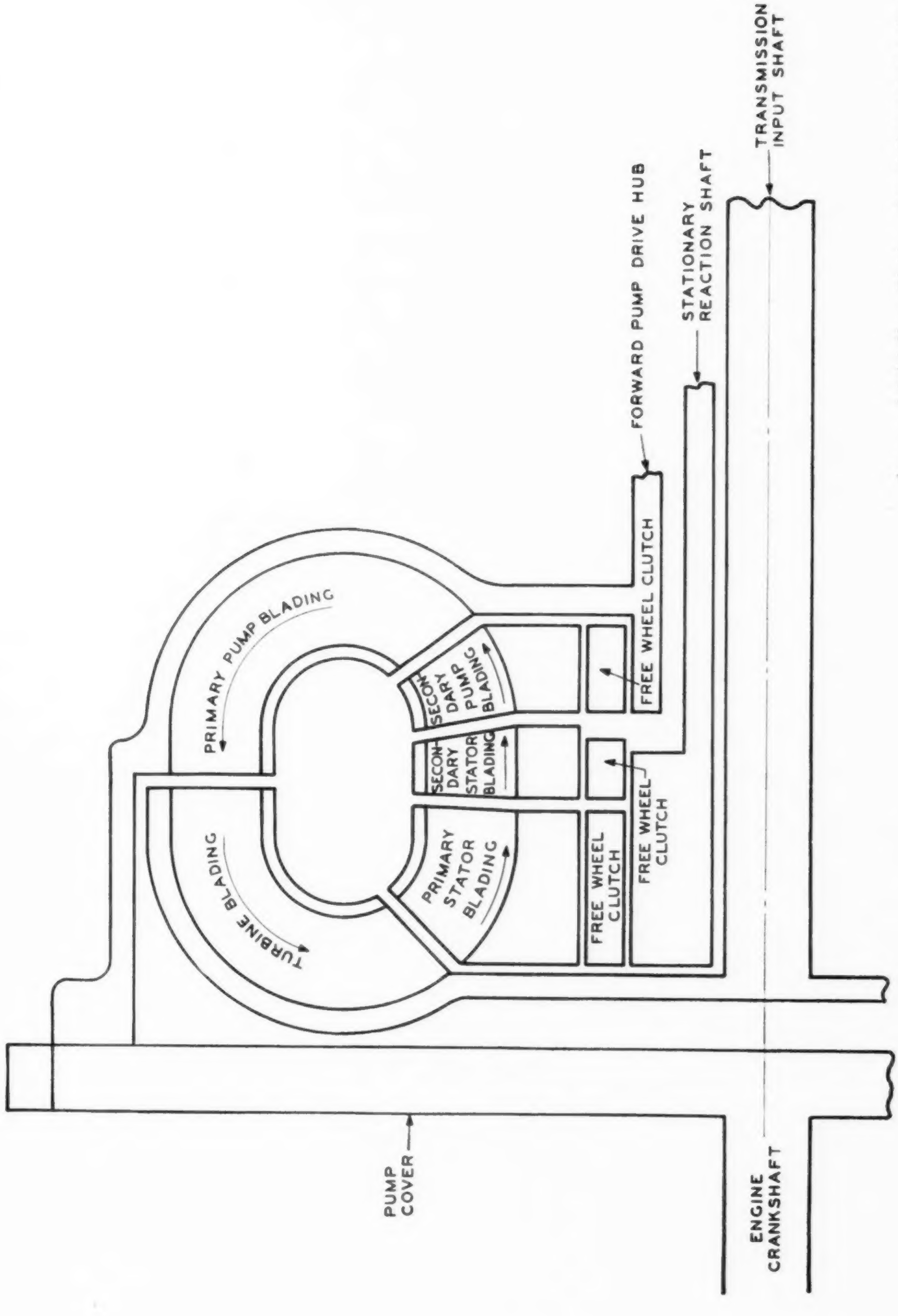
Figure 2 — Principal elements of the Dynaflow combination torque converter — fluid coupling.

TABLE No. 1

INTERNAL OPERATION OF THE DYNAFLOW COMPOUND PLANETARY GEAR

(Note: Rotation and its direction as viewed from front of car are indicated by the words "clockwise" and "counter-clockwise".)

Line Number	Selector Lever Position	Engine	Input Shaft, Driving Clutch Plates, and Driving Sun Gear	Low Band	Low Range, Drum, Clutch Piston Driven, Clutch Plates, and Low Range Reaction Gear	Direct Drive Clutch	Reverse Band	Reverse Ring Gear	Low Planet Pinions Around Own Axes	Reverse Planet Pinions Around Own Axes	Planet Carrier and Transmission Output Shaft	Gear Reduction Ratio $\left(\frac{\text{Input Speed}}{\text{Output Speed}}\right)$
1.	P (Park)	Stationary	Stationary	Released	Stationary	Released	Released	Stationary	Stationary	Stationary	Stationary (Locked)	Infinite (Disconnected)
2.	N (Neutral)	Clockwise	Clockwise	Released	Counter-clockwise (Free)	Released	Released	Clockwise (Free)	Counter-clockwise	Clockwise	Stationary	Infinite (Disconnected)
3.	D (Direct Drive)	Clockwise	Clockwise	Released	Clockwise	Applied	Released	Clockwise	Locked Stationary (Clockwise with sun gear)	Locked Stationary (Clockwise with sun gear)	Clockwise	1.0
4.	L (Low)	Clockwise	Clockwise	Applied	Stationary	Released	Released	Clockwise	Counter-clockwise processing clockwise	Clockwise, processing clockwise	Clockwise	1.82
5.	R (Reverse)	Clockwise	Clockwise	Released	Counter-clockwise (Free)	Released	Applied	Stationary	Counter-clockwise	Clockwise	Counter-clockwise	1.82



Courtesy of Buick Motor Division, General Motors Corporation

Figure 3 — Schematic Assembly, Dynaflow converter — coupling.

nection, attention is invited to the fact that the gear reduction ratios quoted in Table No. 1 pertain only to the planetary itself, and that the converter superimposes its own torque multiplication upon these ratios. For example under stall conditions (engine running but car stationary) and with the Dynaflow in Low Range, the total maximum torque multiplying ability of the whole Dynaflow unit is equal to the product of the Dynaflow's maximum torque ratio (2.25) and the planetaries ratio (1.82), or a total ratio of 4.01. Such a ratio is considerably higher than that provided by low gear in the conventional syncromesh transmission, consequently the Low Range of the Dynaflow provides a very powerful emergency low gear that is always available even though rarely required.

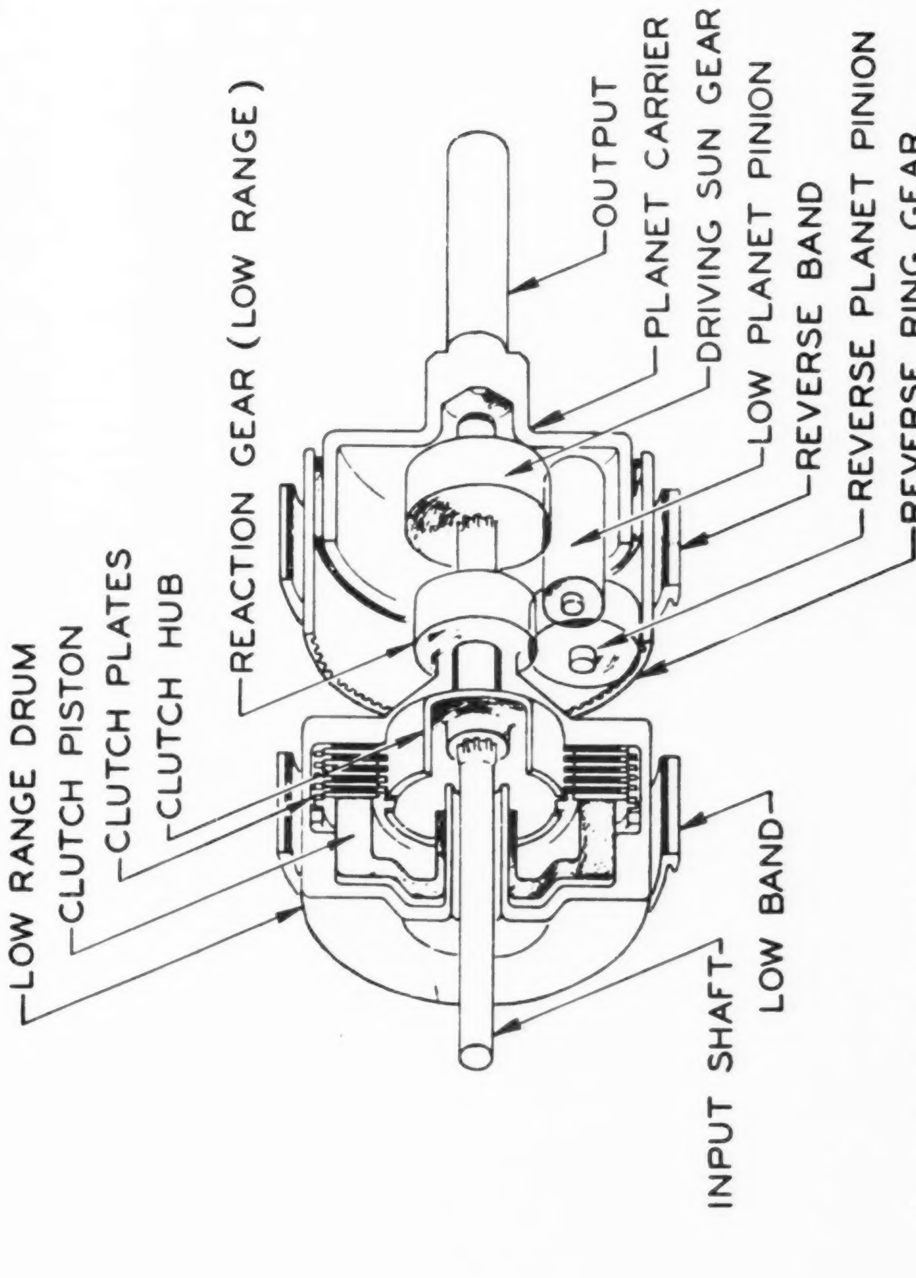
As previously mentioned the action of the compound planetary is controlled by the application or release of two external contracting bands, and a wet type multi-disc clutch. While it would be possible to sacrifice compactness and smoothness by enlarging these mechanisms and controlling them through mechanical linkages, such a design would be extremely cumbersome, sensitive to adjustment, and otherwise unsatisfactory. Buick has wisely chosen to utilize hydraulic rather than mechanical forces for these purposes, and their choice is particularly advantageous because of hydraulic requirements elsewhere in the transmission. The planetary control system is therefore wholly hydraulic but completely controlled by the driver and solely for the purpose of assisting him. Since no gear shifts need to be made during acceleration, there is no need for complicated governing and timing devices.

As may be seen from Figure 5 the principal elements in the hydraulic control system are two oil pumps, three pressure regulator valves, two check valves, two hydraulic accumulators, two band application pistons with their cylinders, one band anchor piston, one clutch application piston, and the shift control valve which is mechanically linked to the steering post selector liner and controls the whole. Cross reference between Table No. 1 and Figure 5 and the following descriptions of individual mechanisms will permit the research-minded reader to trace out the routes and purposes of the several oil flows. The researcher should be warned however that the five possible positions of the shift control valve as shown in Figure 5 are directly opposite to the positions on the selector lever shift quadrant. For example with the shift quadrant in "P" (Parking) position, the shift control valve is pulled to the extreme right: conversely the extreme leftward position of the shift control valve corresponds to the "R" (Reverse) position on the quadrant. As illustrated in Figure 5 the shift control valve is actually in its central and most normal "D" (Driving Range) position.

To insure the availability of oil pressure under all operating conditions, two separately-driven internal-gear type oil pumps are used. The front oil pump which is the largest of the two is located next to the reaction flange concentric with the input shaft and driven by the engine through an extension of the converter's primary pump hub. The rear pump is similarly located within the rear wall of the planetary gear case and driven by the transmission output shaft. The pumps have common intake and discharge lines, and operate either separately or in combination. Both are equipped with check valves in their discharge lines to prevent an active pump from applying pressure to an idle one and thereby causing power waste, and also to prevent the rear pump from sucking on the front pump during reverse gear operation. Since it is driven directly by the engine, the front pump supplies all oil requirements during starting, reverse and low speed operation. At a speed of 45 miles per hour the rear pump capacity is sufficient to take over much of the transmission's requirements. Reference to line three of Table No. 1 will show that the rear pump is most necessary during such "dead engine" operations as towing the car (always in neutral) or starting its engine by pushing, since the rear pump's oil pressure is the only available to apply the direct drive clutch.

The Pressure Regulator Valve is common to both pumps, and in parking, neutral, or drive ranges will maintain a pump discharge pressure of about 85 pounds per square inch. A careful examination of Figure 5 however will show that the regulator consists of more than the usual spring and control valve: this regulator valve contains a step on its piston which may be subjected to oil pressure and will thereby supplement regulator spring pressure with the result that pump discharge pressure is doubled to about 170 pounds per square inch. This higher pressure is required and used to apply and hold either the low or reverse bands. In other words the Pressure Regulator Valve will control oil pressure to either of two values as dictated by the position of the shift control valve.

A further important function of the regulator valve is to fill and keep the torque converter full of oil. A second regulator termed the Converter Pressure Regulator is located in the discharge line of the converter and maintains a converter pressure of about 35 pounds per square inch. The adjacent Lubrication Pressure Regulator utilizes oil discharged from the converter to lubricate the compound planetary and propeller shaft universal joint at a pressure of about 15 pounds per square inch. Mention should be made of the Oil Cooler, a compact heat exchanger of the water to oil type, which is connected between the converter and engine radiator and used to regulate both converter and planetary lubricating



Courtesy of Buick Motor Division, General Motors Corporation

Figure 4 — Schematic of Clutch and Planetary.

oil temperatures.

Reference to lines No. 3 and No. 4 of Table No. 1 will show that operation in the Direct Drive and Low Ranges of the planetary necessitate the rapid but smooth application and firm holding of the direct drive clutch and low range band respectively. As illustrated in Figure 5, auxiliary hydraulic devices known as accumulators are used in the Dynaflow hydraulic system. They are designed to promote smooth engagement by applying the final closing pressure rather slowly. Their action is similar to that of a door closer, which permits rapid closing but prevents slam. As may be seen in Figure 5, each accumulator consists of a cylinder containing a spring loaded piston and an ingenious spring-loaded "dump" (discharge) valve.

The clutch piston, which is readily visible in Figure 1, is spring loaded to keep it in its release position until oil pressure is applied. However when the transmission is operating in either reverse or neutral, the low range drum and clutch piston revolve freely at considerable speed. The resultant centrifugal force on residual oil in the supply line could cause partial engagement of the clutch and consequent damage to its plates: to prevent this a ball check relief valve is placed horizontally in the clutch piston so that it is normally open but is forced closed by the first clutch plate as soon as oil pressure is deliberately applied to the clutch piston. However when the ball check is open, the resultant discharge of oil now creates a vacuum on the clutch piston head: to prevent this another ball check valve (readily visible in Figure 1) is used to vent the clutch piston to atmosphere.

Both the low and reverse bands are engaged by conventional spring-released hydraulically-applied servo cylinders: however the opposite or anchor end of the low band is fitted with another piston called the Anchor Piston. The Anchor Piston is actually an automatic control valve: without entering upon the necessarily lengthy description of how it accomplishes its functions, let it merely be said that the Anchor Piston (a) promotes smooth and positive application of the low band and (b) prevents engine runaway during shift from Low to Drive range under power by insuring that the direct drive clutch is engaging before the low band is fully released. A shift from Low to Drive should not be made if the car speed is about 40 m.p.h.

OPERATION AND SAFETY FEATURES

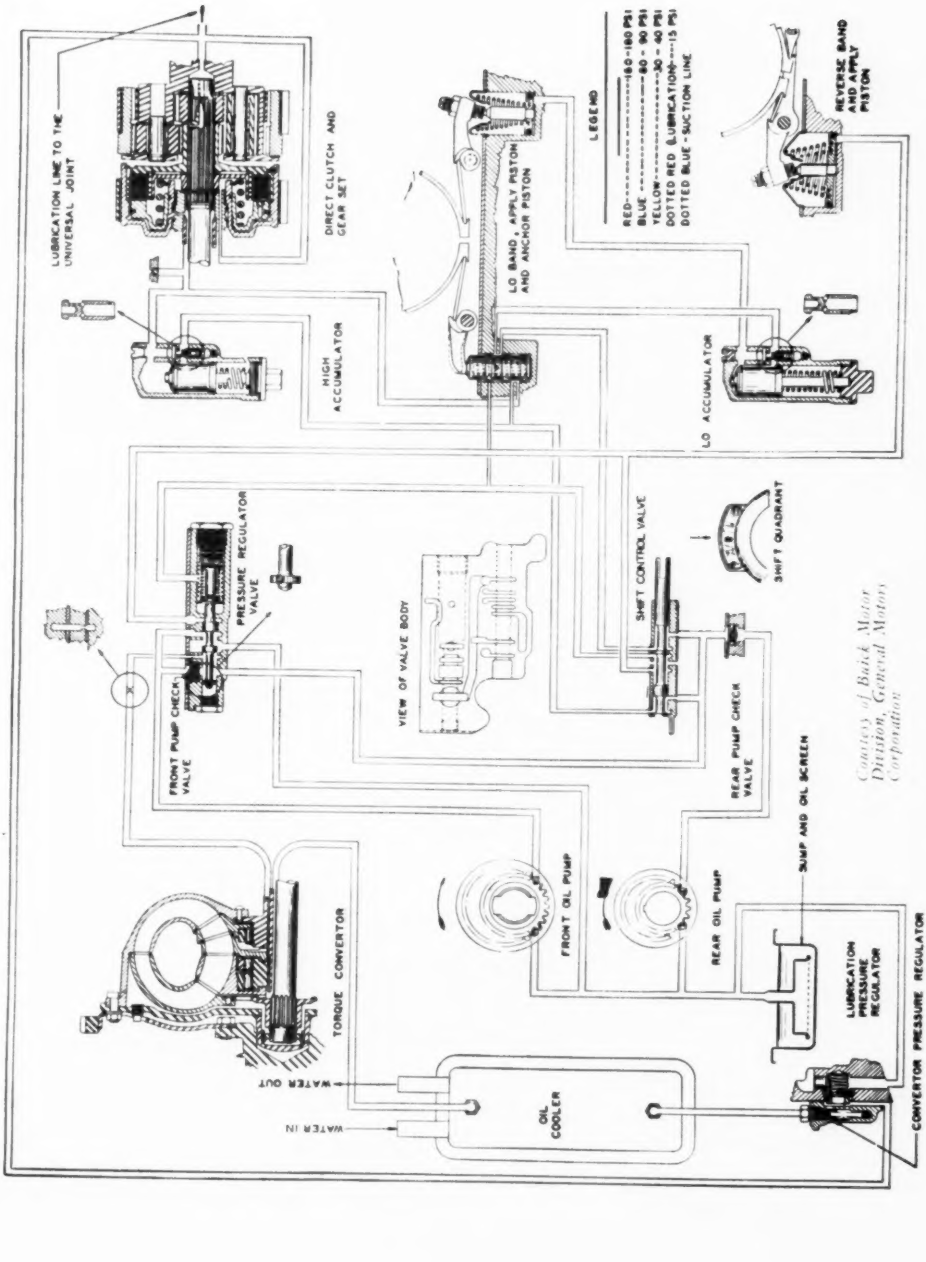
The convenience and safety features of the Dynaflow are well planned. Since the Dynaflow is a powerful mechanism completely at the bidding of the throttle, the designers have made it impossible for the electric starter to function unless the selector lever is in either its "P" (Parking) or "N" (Neutral) position. However if the battery is dead, or it is desired for other reason to start the car by coasting or *pushing*, it is necessary only to place the selector lever in "N" (Neutral) position until the car attains a speed of 15 miles per hour, then move the lever to "L" (Low) position. A Dynaflow-equipped car should always be *pushed* to start it: if the car is pulled it may start and accelerate so rapidly as to overtake and plunge into the tow car. At car speeds of 15 or more miles per hour the turbine (which is now acting as a pump) is spinning fast enough to transmit the considerable torque required to start a dead engine. For this same reason, the Dynaflow is able to utilize the braking effort of the engine during the descent of long gradual gradients, and the normal braking effect can almost be doubled by shifting into "L" (Low) gear.

Since the gears in the transmission are always in mesh, and the hydraulic control system provides the force to make the shift, the driver need only flick a finger at the selector lever without regard for throttle position or speed. Out of ordinary respect for both transmission and engine however, a shift from "L" (Low) to "D" (Direct) should not be made if the car is travelling more than 40 miles per hour.

Again as a safety feature, only the "L" (Low) and "D" (Drive) positions are obtainable through a simple movement of the selector lever: to attain the "P" (Parking), "N" (Neutral) or "R" (Reverse) positions, the driver must first pull the selector lever towards him against the force of a light spring.

In the "P" (Park) position of the selector lever, a pawl attached to the transmission case is mechanically engaged with the Parking Brake Ratchet both of which may be seen in Figure 1 between the rear oil pump and the spiral speedometer drive gear. Since this is a wholly mechanical and rigid connection, it should be obvious that the car must be completely stationary before engaging it. Properly used, the "P" (Park) position is an invaluable safety device when the car must be left on a grade.

Driving a Dynaflow for the first time is a remarkable and long remembered sensation to anyone who has been hitherto accustomed only to a conventional transmission. The Dynaflow's smoothness and rapidity of acceleration without apparent effort both are so deceiving that the driver is more than likely to abuse his privilege, and as usual he will pay for his thoughtlessness in the rather mild form of increased fuel consumption — fewer miles per gallon. The reason for this is quite plain. If at a standing start, the throttle is fully depressed, the engine speed immediately rises to about 1550 RPM (corresponding to about 32 mph in a car with a conventional transmission) even before the car begins to move. If the throttle is kept open, the car will ac-



Courtesy of Buick Motor Division, General Motors Corporation

Figure 5 — Dynaflow Hydraulic and Lubrication System.

celerate most rapidly while engine speed also increases but at a lesser rate until, at say seventy miles per hour, engine speed has increased to 3500 RPM. Under such conditions the engine has been operating at full throttle and at a speed considerably higher than the engine of a conventional transmission, hence higher fuel consumption is to be expected. If however the Dynaflow driver exercises some self-control, he will obtain very good fuel consumption by depressing the throttle only partially during ordinary acceleration and allowing the car to "catch up" with the engine when the desired driving speed is attained. A nervous driver who is constantly "pumping the throttle" will always get lower fuel economy in any car; the flexibility of the Dynaflow will tend to magnify the cost of his nervousness. The Dynaflow is instantly available for a burst of speed when passing other cars; no kick-down device with its invariable jar and interruption of acceleration is needed. Since no clutch is needed or provided the practiced driver can retrain himself to specialize his otherwise useless left foot for the brake pedal and his right foot for the throttle. It is hoped that the car manufacturer will encourage this practice either by gradually shifting the brake pedal to the left, or by providing an extension of the pedal cap itself, so as to permit the use of either or even both feet.

REQUISITE PROPERTIES OF DYNAFLOW FLUID

Oxidation Resistance

Under severe operating conditions the oil-fluid in a Dynaflow can attain a temperature of nearly 300°F. Since the oil is constantly circulated through the converter-coupling and planetary gear it is continually exposed to and intimately mixed with atmospheric oxygen in the presence of highly catalytic metal surfaces, all of which are conducive to oxidation. The resultant sludges or varnishes from even a slight degree of oil oxidation would prevent proper operation of pressure control valves, free-wheeling clutches, blading surfaces and oil cooler, any of which would interfere with the high standard of operation which the Dynaflow attains. The oil should therefore possess a high degree of oxidation resistance. To insure the maintenance of this standard it is advisable to drain and replace the oil every 15,000 and to check its operating level every 1,000 car miles.

Viscosity and Viscosity Index

Theoretically, the fluid for the converter-coupling should approach zero viscosity: actual tests fortunately indicate however that viscosities as high as an SAE 20 motor oil do not decrease converter efficiency to a noticeable extent, and are of course more suitable for lubrication of the planetary gearing, the several sleeve bearings, and the hydraulic system in the transmission. To maintain a high standard of performance through atmospheric temperatures ranging from minus 40°F. through 120°F., a viscosity index of at least 140 is desirable.

Foam Resistance

The presence of excessive or sustained foam must be avoided since it would prevent proper operation of the converter-coupling, depreciate or entirely remove lubrication of other parts, enhance oxidation, and promote "spewing" or overflow of fluid. A fluid having extreme foam resistance is most essential.

Pour Point

The pour point must be low enough to permit oil flow down at the lowest atmospheric temperature usually encountered.

Oiliness

The smooth (non-chattering) engagement of the two bands and wet clutch in the Dynaflow and the number of plain bearings all recommend the presence of a fair degree of oiliness.

Extreme Pressure

Although heavy gear loads are eased somewhat by the presence of the converter-coupling, the provision of some anti-scuff or extreme pressure characteristic is advisable.

Chemical Activity

The fluid must not adversely affect any of the wide variety of metals, gasket materials, adhesives, clutch facing, and band liners which it contacts in the transmission.

Availability

Due to the scarcity of oils meeting these difficult requirements, the manufacturer has participated with others in the formation of a specification covering a single fluid which will give complete satisfaction in all types of automatic transmissions presently manufactured. Fluids which are qualified under this specification are designated "Automatic Transmission Fluid — Type A" and bear an AQ-ATF qualification number, both title and number being embossed or stencilled on all containers. The wide distribution and ready availability of "Automatic Transmission Fluid — Type A" is assured through both car dealers and petroleum company service stations.

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